Can training exercises facilitate the capability to respond to disasters?

YUNG-FANG CHEN[1] & EDWARD BORODZICZ[2]

[1] University of Portsmouth. (e-mail: nicole.chen@port.ac.uk)
[2] University of Portsmouth. (e-mail: edward.borodzicz@port.ac.uk)

Abstract: Natural hazards have doubled in the past twenty years and have become a major global issue. Among these natural hazards, flood hazards dominate over the rest. Although flooding is a natural phenomenon and cannot be prevented, its impacts can be reduced through good flood management strategies.

Traditional flood management approaches are dominated by structural and non-structure measures; however, flood risk can be reduced but cannot be eliminated through the use of these measures. Consequently, the response phase in flood management is highlighted.

Response to floods involves a complex group of agencies, ranging from environment agencies, emergency services, local authorities, utilities, to the people that are directly exposed to floods. It is argued that simulations could play a role in facilitating cross-agency integration and cooperation in dealing with the complex hazards posed by floods through a better understanding of the roles, capabilities, and risk perceptions.

This paper illustrates an exercise being developed to provide flood management and related agencies with experiential learning. This exercise also provided an opportunity to practice decision-making expected in the event of a major flood in the UK. This case study was conducted by an ethnographic methodology. The researcher took part in the 'exercise planning meetings', the 'exercise', and the 'debriefings'. The researcher also interviewed several key exercise-designers and players.

This paper has three purposes:

- Advance our understanding of current flood management in the UK.
- Synthesise the preliminary finding of an observation of a flood training exercise in the UK.
- Consider to what extent a new methodology for conducting training exercises is required.

Résumé: Les catastrophes naturelles se sont multipliéees ces vingt dernières années, à tel point qu'elles sont devenues une préoccupation majeur sur la scène internationale. Parmi ces catastrophes naturelles, les inondations tiennent une place particulière compte tenu de l'ampleur des dégâts humains, matériels et environnementaux. Certes, il n'est pas possible d'empêcher de tels phénomènes naturels. La mise en place de strategies efficacies pour gérer les consequences des inundations permettent toutefois d'en limiter leur impact et de réduire le nombre de victims.

Les approches traditionelles établies pour gérer les inondations comprennent à la fois des mesures structurelles et non-structurelles. Cependant, ces techniques ne permettent pas de supprimer le risque d'inondation et ne font que le mitiger. Par conséquent, il est crucial de se pencher plus avant sur la phase de réponse.

De nombreux acteurs sont impliqués dans la gestion des inondations allant des agences spécialisées comme les agences environnementales, des services d'urgences, des autorités locales, des entreprises de services aux victimes mêmes. L'organisation d'exercices de simulation pourrait jouer un rôle de catalysateur pour faciliter la communication et la coopération entre les différents acteurs et contribuer à mieux définir la distribution des rôles, les moyens d'agir ainsi que l'évaluation des risques.

Cet article présente un exercice de simulation qui a été réalisé dans le but de fournir aux acteurs en charge de gérer les inondations, en particulier les agences spécialisées, un savoir pratique. Cette simulation a également permis de tester les mécanismes de prise de décision dans le cas d'une inondation majeure en Grande-Bretagne. Cette étude de cas a été réalisé en se basant sur une méthode ethnographique. Le chercheur a pris part aux réunions de préparation de l'exercice, à l'exercice lui-même, ainsi qu'aux évaluations finales. Le chercheur a également été en mesure d'interroger plusieurs acteurs clés impliqués dans la planification et la réalisation de l'exercice.

Cet essai poursuit trois buts:

- Progresser dans notre compréhension des méchanismes actuels de gestion des inondations
- Réaliser la synthèse des conclusions préléminaires d'une analyse d'un exercice de stimulation de gestion d'inondation en Angleterre
- Envisager les besoins de créer une nouvelle méthode pour mettre en place des exercices de simulation.

Keywords: floods, education and training, case studies, models, planning, risk assessment

INTRODUCTION: FLOOD HAZARDS AS A GLOBAL AND LOCAL PROBLEM

Flood hazard has become a major problem around the world. It is estimated that over two-thirds of population and one-third of property damage/losses affected by natural disasters were involved in flood hazards from 1950 to 2000 (Pilon 2004, p.4). It is further predicted that more flooding would take place in the following years (Arnell 1998; Wang, Wu & Xiouhuafu 2000; Alcantara-Ayala 2002). Human development has led to the increasing incidence of

flooding; for example, the expansion of cities in flood-prone areas in the industrialised countries (Fleming 2001) and shantytowns alongside the riverbed or coastal areas. Some scholars believe that human behaviour contributing to the change of climate also causes the increasing number of floods (IPCC 2001).

Floods are natural phenomenon which "cannot be prevented" (Flemming 2001, p.5); however, it is believed that its impact could be reduced through good flood management strategies (Penning-Rowsell 1998; Fordham 2000). Through history humans have fought with floods (Wohl 2000, p.1). However, modern flood management only dates back to the 19th century (Wohl 2000, p.1).

The current approach to flood management can be divided into three paradigms: the engineering, behavioural, and total disaster risk management (Chen, Borodzicz & Chao 2003). The next section aims to introduce concepts and applications of each paradigm to flood management.

FLOOD MANAGEMENT

Engineering paradigm: structural measures

The engineering paradigm has historically dominated all over the world. This paradigm believes that building structural defences or flood control systems could prevent potential disasters (Smith & Ward 1998, pp.205-206; Brown & Damery 2002). Examples of structural defences include:

- Levees or floodwalls/seawalls to prevent development of floods.
- Diversion structures to direct flow away from the protected region during the peak.
- Channel modifications to increase the hydraulic capacity or stability of the river.
- Building reservoirs or dams upstream to store floodwater from the protected community and release it at non-damaging rate (Petak & Atkisson 1982; Handmer 1987; Parker 1995; Smith & Ward 1998; Simnovic 1999; Wohl 2000).

Behavioural paradigm: non-structural measures

Since the 1930s, it has been argued that it is human behavioural failures on floodplains which cause continuous flooding. For example, those structural measures create a 'false sense of security' (Smith & Tobin 1979, p.5). People believe that it is safe to live inside the floodwall; however, once it is breached, people in the society may suffer more damage from the flooding (Smith & Tobin 1979, p.5). In order to overcome weakness of structural measures, White suggested including two approaches: flood abatement and non-structural defence.

It is argued that non-structural measures are more acceptable to the public in terms of environmental perspective. Moreover, it is less costly than traditional structural solutions (Brown & Damery 2002). Non-structural measures emphasise:

- Zoning (Penning-Rowsell & Handmer 1988; Parker 1995; Gupta, Suresh et al., 2002).
- Flood warning systems (Penning-Rowsell 1998; Fordham 2000; Golding 2000; Alcantara-Ayala 2002).
- Evacuation (Faisal, Kabir et al. 1999; Fordham 2000; Handmer 2001; McEwen, Hall et al. 2002).
- Insurance (Arnell, Clark et al. 1984; Pynn & Ljung 1999; Burby 2001; Crichton 2003).

Abatement methods are also applied to mitigate the damage of potential flooding. For example, topographic modification – including terracing and contour ploughing, surface and underground water storage, and gully control. In the perspective of vegetation modification, grassland, crop and forest cover methods are applied (Smith & Wards 1998).

These emphasises largely rely on quantitative, scientific and technological techniques. However, the validity of these methods is questioned. Adopting Pielke's (1999) fallacies to flood management, weaknesses of non-structural measures could be summarised as following points:

- Flood frequencies are well understood: This standard is based on past flood records, and therefore it is subject to deviations regarding the probabilities of future floods (Stoop 2003; Fordham 2000). In addition, there was parametric and system uncertainty of the return period due to human behaviours, for example, the change of the hydrology system (Pielke 1999).
- Flood forecasts are universally available: Although real-time techniques to predict flooding have been improving; there is still lack of a generalised measurement. In addition, the ability of decision–makers to use these facilities is doubted (Green 1983).
- Societal vulnerability to floods is well understood: Data of social and population at risk has not been well collected and stored, and therefore, the real value of flood damage has been under-estimated (Penning-Rowsell & Handmer 1988).
- Data on flood casualties/damage is a proxy for flood risk: The validity to use quantitative data, for example casualties or quantitative risk assessment, to measure flood risk is questioned (Weick 1998; Stoop 2003). Social, and psychological factors should be also taken into consideration (Green 1983).

Due to the weakness of the traditional flood management, research should broaden its scope to include studies of the social impacts of floods and flood mitigation schemes (Penning-Rowsell & Handmer 1988). It is suggested that social approaches should be embedded into flood management work (Green et. al. 1987).

Total disaster risk management

Current disaster management is moving toward a more holistic and total management framework; subsequently, flood management is integrated in this holistic structure. This paradigm was stated in the late 1970s. Scholars set up an emergency life cycle – mitigation, preparedness, response, and recovery – to comprise strategies to deal with disasters (Public Administration Review 1985). Clark uses this framwork to demonstrate key elements of flood management:

Table 1. Table of total disaster risk management framework

Pre-disaster phase	Risk Identification	Hazard/risk assessment Hazard monitoring
	Mitigation	Physical/structural mitigation works Floodplain management
	Risk Transfer	Insurance/reinsurance of public infrastructure and private assets Calamity funds
	Preparedness	Early warning system/communication systems Contingency planning
Post-disaster phase	Emergency response	Humanitarian assistance Clean-up, temporary repairs and restoration of services Damage assessment
	Rehabilitation and reconstruction	Rehabilitation/reconstruction of damage critical infrastructure Macroeconomic and budget management Incorporation of disaster mitigation components in reconstruction activities

Source: adapted from Clarke 2000, p.13.

In order to integrate elements listed in the table, there has been a tendency to build a 'total' and 'holistic' public administration system. However, the new framework brings about a potential problem: the complex structure might not deal with crisis situations. Denis (1991) uses seven points to sumarise potential problems in this bureaucractic system:

- Official, well-defined jurisdiction: The first problem in the total disaster risk management structure is the grey areas regarding jurisdiction (Quarantelli 1998, pp.373-385). The distribution of responsibilities could be a major issue for agencies involved when a great magnitude disaster occurs (Schaafstal et al. 2001), particularly in the events that require agencies from different jurisdiction areas, for instance, different counties or countries.
- The hierarchy of authority: Cooperation and coordination among different agencies are important while dealing with disasters; however, different organisational structure/hierarchy in different agencies is a potential problem (Comfort 1985; Fordham 2000; Dobson et al. 2001). Complex hierarchy systems might lead to a communication problem.
- Command and control: The top-down command and control procedure in the emergency services delays the effectiveness of responding to emergencies. It also restrict the communication among agencies at parallel level (Handler 1986; Comfort 1994; Boin & Ottn 1996, p.150). For example, the tactic police officer should follow their strategic commander's order; however, in reality, it might be more efficient if the tactic police officer makes decisions with tactic officers from other agencies, than report to their strategic commanders.
- Specialisation/expertise: It is impossible for emergency response officers to understand all types of disasters and ways to deal with them due to fast developing technologies (Pielke 1999).
- Volunteer/non-volunteer groups: Volunteer groups get involved in responding to disasters very quickly. Although they bring along a lot of human power and resources, they might also intervene and/or intrrupt the operation of the public administration system.
- Full-time, paid position: Large-scale disasters usually take a long time to respond to, subsequently, a shift system is essential for rescuing actions. However, full-time officers have routine working hours. Although extending working hours to respond to disasters is included in their job description, extra payout and 24-hour working shifts could be problematic (Dennis 1991).
- Written information as a management tool: Although written information is an effective method of storage and transferring data/knowledge, it may also postpone the time for emergency service personnel to respond to hazards. In addition, it provides a justification for officers working in public administration (Comfort 2000). Consequently, it is suggested there is a need to design a systematic pattern of communication and computer-based information structure (Comfort 2000).

USING PSYCHOLOGICAL, CULTURAL, AND SOCIAL APPROACH TO RISK TO EXAMINE THE WEAKNESS OF TOTAL DISASTER RISK MANAGEMENT

It has been suggested to use a social approach to risk examining the weakness of total disaster risk management. Studies of risks can be dated back to ancient Egypt, Greek and China (Borodzicz 1997). Modern risk management began in the seventeenth century relating to the mathematic probability theory (Hacking 1975; Todhunter 1865). In the past twenty years, psychological, cultural, and social context have become a major theme in risk studies.

Psychologists study how "individual attitude, beliefs, and feelings" (Pidgeon et al. 1992) influence people's risk perception. First of all, scholars conducted many surveys to prove individual subjectivity could change their risk perception (Blockley 1980). Secondly, psychologists attempted to use scientific methodology to generalise risk as a 'normal science' (Lischhoff, Lichtenstein, Slovic, Derbey & Keeney 1981).

Further research into risks uses a social, cultural and political approach (Oltedal, Moen, Klempe & Rundmo 2004). This approach highlights the importance of group and organisational influences. Scholars look into the interaction, coordination, and cooperation among agencies regarding exchanging risk perceptions. Research finds that people from the same group would share similar risk perceptions (Douglas 1978; Douglas & Wildavsky 1982; Sjöberg 2001). Research also examines differences between different groups, for example, experts and non-experts (Slovic & Fischhoff 1982).

Due to the requirement of the government to inform the public about the environmental, health and technological hazards that people might confront in the 1970s, risk communication theories have started to look into the communication between public administration and the public, for example, trust (Covell et al. 2001; Sjöberg 2001; Oltedal 2004), noise (Ellis & McClintock 1990; Seeger 2002), and social amplification (Kasperson et al. 1998).

Current approach to risk communication focuses on organisational communication. Studies investigate how conflicting organisations communicate risk perceptions and find mutual understanding and consensus (Taylor & Cooren 1997, p.409).

Turner used a system approach to examine risks. He argued that the majority of large-scale accidents are caused by a combination of individual, group, social and organisational factors. Most of the time, disasters are caused by socio-technical, rather than technical factors alone (Turner 1978). He illustrated six stages of how a disaster develops within an organisation: "(1) the notionally normal starting point; (2) the incubation period; (3) precipitating event; (4) onset; (5) rescue and salvage; (6) full central readjustments. Further, Turner used a 'systematic report analysis diagram' to examine disasters and summarised four factors why organisational failures occur:

> "(1) Events unnoticed or misunderstood because of erroneous assumptions; (2) Events unnoticed or misunderstood because of difficulties in handling information in complex situations; (3) Effective violations of precautions passing unnoticed because of cultural lag in existing precautions; (4) Event unnoticed or misunderstood because of reluctance to fear the worst outcome."
>
> (Turner 1978, pp.100-103)

Information disjunction, particularly, is the key factor to system failure or system breakdown (Weick 1988; Pidgeon & O'leary 2000). The purpose of an organised system is to establish "more orderly, more consistent, and to reverse centrifugal tendencies toward entropy, disorder and fractionation" (Weick 1998, p.72). However, when an accident or a hazard occurs, the consistencies breakdown because too many people get involved in dealing with the same event at the same time. Information overload and time limit prevent people from accessing comprehensive information; consequently, the accident may develop into a disaster.

Charles Perrow in his book *Normal Accident* (1984) argues that catastrophic accidents will repetitiously occur in the modern technological industries in the future. The problem is caused by system, rather than human factors. Although a few large industries have attempted to achieve higher reliability culture, it is not possible to avoid accidents in a complex organisation (Lagdec 1997, p.24). Perrow argues that:

> "If interactive complexity and tight coupling - system characteristics - inevitably will produce an accident, I believe we are justified in calling it a normal accident, or system accident. The odd term normal accidents is meant to signal that, given the system characteristics, multiple and unexpected interactions of failures are inevitable. This is an expression of an integral characteristic of the system, not a statement of frequency. "
>
> (Perrow 1984, p.5)

Toft and Reynolds (1997) recommend that organisations could prevent disasters through isomorphic learning process. Due to the similar inner elements within an organisation, any failures in one organisation could occur in similar systems or similar reasons (Toft & Reynolds 1997, p.25). Subsequently, they suggest that learning from other organisations - or so-called organisational isomorphism – could prevent future disasters.

Walsh and Healey (1987) argued that 'disasters' continue to occur again and again simply because little is learnt from each disaster:

> "The occurrence of a disaster usually overwhelms those affected by it when there has been no planning or preparation. Even in situations that are repetitions of previous calamitous events, people often seem to be unprepared. The annual flooding of certain rivers offers a prime example of this category. Residents will repeatedly be devastated, but each time is no better equipped than the time before."
>
> (Walsh & Healey 1987, p.10)

Responding to floods involves the coordination of a complex group of agencies, ranging from emergency services, local authorities, government bodies, and utilities. They quickly respond to hazards and complete their own tasks and responsibilities. If these agencies could not establish and develop new systems of relations, information and interaction, the system would break down (Lagadec 1997). It is argued that simulation, which is the best method for an individual and organisation to learn from each other's experiences, can produce more balanced results (Lagadec 1997; Stern 2002; Borodzicz 2005). These experiences include acquisition, development, and transfer of competencies necessary for effective performance (Schaafstal et al. 2001).

USING SIMULATION EXERCISES TO FACILITATE CAPABILITY TO RESPOND TO DISASTERS

What is a simulation exercise?

Simulation exercises have been used by the emergency services for a long time in order to improve knowledge, skills, and attitudes (KSA) in responding to accidental events (Legadec 1997; Stern 2002; Borodzicz 2005). Simulations are usually divided into three types: tabletop, live exercise, computer-based. Tabletop simulations are often provided for managerial personnel, and it is normally run as paper-based. It seeks to represent a simulated incident atmosphere by providing participants with interactive messages. Live simulations are also called practical, operational or field exercises (Environment Agency 2003[1]). They simulate realistic scenarios in order to familiarise participants with capabilities and limitations of equipment while dealing with incidents.

It is necessary for simulation planners to consider elements such as planning, preparation, execution, analysis, performance measurement, and feedback (Oser 1999; Borodzicz & van Haperen 2003) while designing a simulation. Designing an effective simulation does not have a single set of rules. It depends on the context of their use: what is the main purpose, who are the participants, how much time and resources are available? Loveluck (1994) illustrated eight elements that should be considered before designing a simulation:

"1. Simulation should display an external simplicity which masks their internal complexity.
2. Games should have some theoretical underpinning.
3. Games should contain 'an element of surprise'.
4. The social structure of the group of players may conflict too strongly with the desired players and also the desired power structure in the game.
5. In management training, 'verisimilitude' is valued more highly than realism.
6. There is a difference between running and merely administering a game.
7. Games are culture sensitive.
8. All simulation games will display 'an emotional impact'."

(Lovelock 1994)

Simulation exercises provide an effective learning environment for emergency services (Borodzicz 1997; Ford & Schidt 2000; Schafstal & Oser 2001). Two questions need to be asked to help define what an effective learning environment is: (1) why do simulations facilitate learning outcomes? (2) What emergency service personnel need to learn? This section uses learning theories to answer the first question. In addition, this section attempts to explore the breadth, depth, and types of expertise to answer the second question.

Why do simulations facilitate learning outcomes?

Who learns?

- *Individual learning*

Using learning theory to link simulations and learning has become a trend. Scholars use individual learning (for example, Piaget 1972; Kolb 1984) and team/organisational learning (Mintzberg & Winter 1989; Senge 1990; Schein 1992; Cannon-Bowers, Tannenbaum, Salas & Volpe 1995; Cannon-Bowers Salas & Converse 1997) to examine the learning process and learning results.

From the individual perspective, it is believed that simulations can improve mental models (Pidgeon et al. 1982; Richard 2000; Pengelly 2001). A mental model is "a representation of an individual's perception of the world and ways of using this knowledge" (Dobson et al. 2001). Through assimilation, people enhance their schemas and cognitions (Bloom 1984; Richard 2000). Assimilation is a process to integrate existing and new knowledge.

Kolb extends mental models to establish experiential learning theory (1984). Knowledge is created through transforming experiences and reflection. From this ongoing and repetition cycle – which comprises concrete experience, observation and reflection, forming mental models, and applying and testing conclusions – people gain knowledge. It is when authentic learning takes place (Dewey 1938). Simulations offer participants a great chance to receive experiences related to their work (Ulrich 1998).

- *Organisational learning*

Learning does not only occur at the individual level. It also occurs at the team, group, or organisation level. Modern teams, groups, and organisations have gradually replaced the individual as the essential learning unit (Senge

[1] Environment Agency Management System Document, Procedures for the Design, Planning and Conduct of Exercises.

1990). In a dynamic and competitive environment, inter-organisational departments are the best learning units (Senge 1990; Stern 1997).

Contingency theorists premise that an organisation is an open system, and it adapts itself to the environment. Hence, learning occurs un-planned and emergent (Cyber & Arch 1963; Meyer 1982). The psychological organisational learning regards organisations as a system that comprises beliefs and values. Members in the organisation would establish collective language to interact with their environment (Weick 1979). Information theorists consider an organisation as a place to 'acquire distribution, interpret, and store information (Huner 1991). Current organisational learning theorists believe that an organisation is a dynamic and complex entity (Senge 1990), which regards the society as a 'circle of causality' (Romme & Dillen 1997). Subsequently, system dynamic theorists consider organisational learning as a cohesive and holistic process (Morgan 1986).

Theorists tend to use the team mental model – which includes the shared mental model and team situational model - to explain learning activities have taken place; particularly, it addresses task work and team work (Klimoski & Mohamed 1994; Cooke et al 2000). Shared mental models are shared knowledge that team members have, it is established between a dyad of individuals when they work together, for example task work and team work (Oser et al. 1999; Langan-Fox et al. 2001). Team situation models are more dynamic and more people are involved in the knowledge sharing and task progression procedure (Endsley 1995).

Most interdependent team activities and sub-tasks require more shared knowledge and skills to effectively manage these interdependencies, particularly emergency services teams. Through team mental models, it is easier to understand other people's tasks and responsibilities (Cannon-Bowers et al. 1995; Dobson et al. 2001).

When does learning take place in simulations

A simulation exercise could be divided into three phases: game design, game session and real life. The 'Game Design' phase includes schematic and multiple testing known as 'Rule of 10' – *see below for detail*. The 'Game Session' phase includes the entire session and the debriefing. The 'Real Life' is the transferring process of simulations to practice (Ulrich 1997). This combination could be demonstrated in Figure 1.

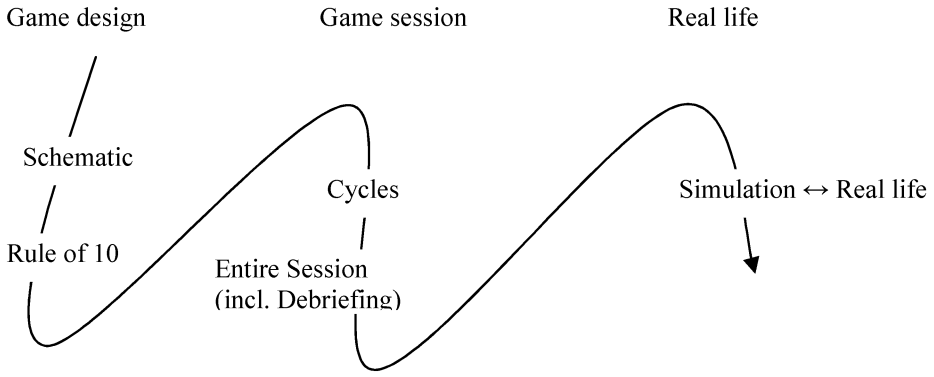

Figure 1. Elements of simulation related to the experiential learning cycle.
Source: Cited in Ulrich, 1997.

When designing a game, it is crucial to list relevant elements of the system, ranging from technical to artistic performance (Geurts 1997; cited in Ulrich 1997). Planners should evaluate the design from feedbacks and adjust or revise the design of the simulation. According to Duke, a new simulation exercise should be tested *ten times* after it is designed/before it is available (Duke 1980). After each test is finished, advantages and weaknesses should be identified in order to revise and polish the simulation exercise. This repetitious testing is related to the learning cycle (Ulrich 1998).

Players complete the whole experiential learning cycle in a simulation and learn new knowledge, skills and attitudes in the game session. When they experience similar situations in real life, they would apply what they have learned to practice. The game session provides players opportunities to gain experience by learning from observing others. In addition, debriefing is highlighted in the game session phase. Through instructed debriefing, players establish their concrete experience through feedback from other team members or from their own observation.

In the last phase, players transfer their experiences to their real life. When they confront similar situations in real life, they would apply what they have learned to practice. Planners re-evaluate the simulation and then make revision. It could be the guidance for the next simulation.

During these phases, organisations involved in the simulation also learn from accumulation of information, document and reports. They also learn from the interaction among players, and players and planners. In the end, new values, beliefs, and procedures would be produced among these organisations. Table 2 demonstrates when and who learns in different phase of a simulation.

Table 2 Learning activities taking place in simulations

	Simulation design	Simulation session	Real life
Planners	*	*	*
Players	-	*	*
Organisations	*	*	*

What emergency service personnel need to learn?

Expertise can be defined as 'the mental processes acquired through experiences and training (Ford & Schmidt 2000). Normally, scholars use three dimensions to examine expertise: the breadth of expertise, the depth of expertise, and the types of expertise.

The breadth of expertise looks into an individual's career progression in terms of experiences gained and learnt within an organisation, which includes individual competencies, interpersonal competencies, and system competencies (Ford & Schmidt 2000). The depth of expertise looks into the novice and experienced personnel inside an organisation, because the differences between them would influence an organisation's overall performance. It can be examined in terms of: "(1) proceduralised and standardised knowledge, (2) qualities of mental models, and (3) self-regulating systems" (Ford & Schmidt, 2000 p.620). Analysing the breadth and depth of expertise helps simulation exercise planners to define what participants' responsibilities and capabilities are in their position. It could further identify what they should learn in the exercise.

In addition, scholars divide expertise into routine expertise, which refers to an individual's ability to respond to a normal situation with a set of well-organised procedure and adaptive expertise, which is related to the competencies to respond to crisis situations. These categories are particularly important for designing a flood simulation exercise, because it helps planners to identify what are knowledge and skills that players are required to obtain in order to respond to abnormal situations.

Effective emergency management requires good communication and coordination within and between agencies (Lagadec 1997; Dobson et al. 2001; Schaafstal 2001). Four principles for emergency response include: (1) ability distribution and communication; (2) adaptability; (3) classification of the actors; (4) distribution of tasks (Wybo 1998).

Due to the nature of the emergency, emergency managers face situations such as ill-structure (Turner 1978), dynamic environments (Fordham 2000), shifting or competing goals (Schaafstal et al 2001), time stress, and high stakes (Lagadec 1997). In flood hazards, decision makers confront with following uncertainties:

- "It is difficult to predict precisely where will be flooded.
- Flooding takes place at very short time.
- Flood could occur at many places at the same time.
- Special rescue vehicles and equipments are required."

(Chen 2002)

These could be barriers in the communication process. They prevent decision-makers from communicating and disseminating decisions, as well as coordinating with other agencies. These identified principles and ways to deal with uncertainties are what officers need to learn in a simulation.

CASE STUDY

Methodology

Ethnography is a qualitative research methodology regarding a long-term observation of a group of people in their natural setting of everyday behaviours and activities (Geertz 1973; Gill & Johnson 1997). It has been developed to analyse, examine, and describe cultural, sub-cultural, social, and political systems in order to communicate this understanding to a wider audience (Lloyd 1998; Gonzalez 2000, Rosenberg 1999; Lloyd & Deasley 2000). Due to its nature of detailed investigation and interpretative method, an ethnographer could be regarded as an academic journalist (Johnson & Duberley 2000).

Due to the complex, dynamic nature of contemporary flood simulation and training exercises, using the ethnographic approach enables the researchers to understand current design, conduct, and debriefing of flood exercises in England. Using this research methodology allowed four research processes to unfold simultaneously:

- Providing an understanding of flood management regulations, acts and structures in England.
- Introducing a relatively untried method for understanding the ideas, behaviours, and cultures of agencies relating to responding to floods.
- Allowing access to recover the inherent properties of communication and the exchange/learning expertise in simulations and training exercises (Davis & Henze 1998).
- Advancing a better understanding and investigation of flood simulations design, conduct, and evaluation.

Fieldwork is the main method for data collection in ethnographic studies (Hussey & Hussey 1997; Fetterman 1998). In order to complete the fieldwork, several tactics are used in this research (Hammersley & Atkinson 1983; Fetterman 1989). First, the researcher continuously wrote field-notes and diaries in order to record what is observed.

Secondly, the researcher found out and contacted the 'gatekeeper' – an emergency planning officer in a city council- in order to get in to the group who were planning the flood exercise. The gatekeeper is the one who has the most influence, or know the most about what is going on, in any research setting (Fetterman 1989). 'Blend in' is the next step to the research. Researchers are required to become a member of the society. If researchers remain noticeable, people being observed will act differently, which may cause the invalidity of the study. In the meantime, it is also necessary for researchers to be an 'outsider'. They should be able to objectively analyse and criticise the observed setting. This is also called going native (Fetterman 1989). The researcher was welcomed by the exercise-planning group, and also obtained permission to observe every planning meeting and have access to official documentation relating to this exercise. The researcher also observed the exercise and following debriefing sessions.

Subjectivity and the reliability/validity of ethnographic texts have been the main criticism of ethnographic methodology (Sechrest & Sidani 1995; Henning-Stout 1999; Sim 1999; Benwer 2000; Manson 2002). In order to overcome bias, the researcher used multiple methods to triangulate the results of the research, which included data collection and interviews (Gill & Johnson 1997).

However, due to the length of the paper, the researchers are not able to use the 'thick description' (Geerts 1973) to write up the case study. This paper could only provide the summary of the observation. Due to the nature of this methodology, the following chapter will use the first person 'I' to record the observation. In addition, in order to remain the anonymity, the researcher gave the exercise, planners and players different names.

Background of the case study[2]

Exercise 'Big Wave' was a national flood exercise which was organised by the Environment Agency (EA) on behalf of the Cabinet Office, the Department of Environment Food and Rural Affairs (DEFRA), the Welsh Assembly Government (WAG) and other agencies involved in responding to flood hazards, including category 1 responders (Civil Contingency Act 2005), such as emergencies services and local authorities, and some category 2 responders, for instance, utilities. This exercise covered four regions and nine counties. There were in total thirty-five control posts in operation during the exercise.

The general scenario for the exercise was based on a 1 in a 1000-year storm, followed by flooding based on a 1 in a 200-year tidal flood. These general scenarios were produced by a private consultant agency employed for this purpose by the EA. Each control post was required to hold independent planning meetings in order to design the 'main event list' and the 'schedule of injects[3]'. Although all control posts played simultaneously, each control post might conduct different types of exercise in accordance with their perceived requirements.

I[4] was invited to observe the design, conduct, and debriefing of the exercise in one of these control posts which was located somewhere in southern England. In this control post, six planning meetings were held in the planning progress. Planning meetings began in December 2003, and continued to the date of the exercise, which was run in June 2004. After the exercise, I also took part in the structured-debriefing session[5]. The table below summarises the dates of planning meetings and their main focus.

Table 3 The Dates and Objects of the Planning Meetings

Meeting	Date	Objectives of meeting
1st meeting	10/12/03	An introduction of the Exercise Big Wave: the aims and objectives.
2nd meeting	19/01/04	Development of the scenario.
3rd meeting	24/02/04	To clarify the emergency management structure and control post layout.
Internal	04/03/04	Inject schedule of the exercise Day-1 and Day-2.
4th meeting	19/04/04	The change of scenario of the exercise Day-2.
5th meeting	10/05/04	Inject schedule of the exercise Day-2.
6th meeting	20/05/04	General report of the Exercise Big Wave.
Exercise Day-1	16/06/04	Exercise Day-1: T Day[6]
Exercise Day-2	17/06/04	Exercise Day-2: T+ a month + a year[7]

Due to the limit of the paper, brief summaries of what occurred at the meetings and exercises are presented. The first meeting was to confirm the sub-group members and the introduction. The main aims of the exercise were to test the coordination and communication between the DEFRA and the EA, but local authorities and emergency service teams were required to take part to assist in this exercise.

The aims of this exercise were to:

- "To help ensure a seamless and integrated response to flood forecasting, flood warning, and emergency response;
- By placing greater emphasis on testing response activity, and interfacing and cooperation, with extreme event scenarios.

[2] Due to anonymity, the name of the exercise and participants' names are re-created.
[3] 'Inject' refers to the orders or commands that players would receive during the exercise. For example, a fire fighter might receive an 'inject' such as 'the supermarket in the city centre is flooded.' Next, the fire fighter should make decision or take an action to respond to this inject.
[4] In light of the research methodology, the author used the first person 'I' to write up the case study.
[5] Structured-debriefing is a police headquarter debriefing format. It is widely used in the emergency services, and some other organizations. It is believed that this simple, effective debriefing format helps to facilitate players reviewing and reflecting from the simulations and training exercises. The center for structured debriefing, from http://www.structured-debriefing.co.uk/2structured_debriefing.htm
[6] T Day refers the simulated time: the day when the flood occurred.
[7] It refers to the simulated time: one month and one year after the flood occurred.

- To achieve this we will deliver a national exercise in accordance with DEFRA's and the WAG's high level target 3 A."

(Sherman, Exercise Big Wave 04 Planning Document 2003, p.1)

Each control post was required to test:

- "The effective actions and the interactions of Control Posts.
- The capacity and adequacy of Resources.
- The effective deployment of Resources."

(Sherman, Exercise Big Wave Planning Document 2003, p.B-1)

Attendees in the first meeting also discussed how planners would assist to develop the scenario for the exercise. Planners should provide the consultant company 'injects'. Each inject should comprise the following factors:

- " Reference number
- Who / Where it was initiated from
- Time of initiation
- Its distribution (who/where it's going to)
- Type of injects
- Details of injects
- Expected response
- Validation flag"

(Sherman, Exercise Big Wave 04 Planning Document 2003, p.4)

The second meeting was to discuss the development of the scenario on the exercise Day-1. Attendees argued over several subjects, which included

1. Mapping and the main event list: the fidelity of the event.
2. Injects: the relation of each inject.
3. The debriefing session: how to conduct the debriefing.
4. Number of players.
5. Purposes and the emergency plan: clarify each agency's responsibilities and roles.

The main subject of the third planning meeting was to discuss the change of the objective and successful criteria of the exercise.

"1. The national Lead Department's plans are exercised
   - DEFRA
   - CCS's co-ordination of cross govertment response to a national emergency
2. The new regional tier is exercised in at least 2 Government Offices
3. All major partners will engage positively & benefit
4. For each partner, at and between each tier, it will test
   - actions & interactions of the control post
   - effectiveness of plans
   - adequacy of resources
   - communications"

(Denver Porter, Exercise Big Wave 04, Generic Briefing Presentation, February 2004)

Although these successful criteria clarify what planners should do, attendees were frustrated because there was not much time left. In addition, those efforts that they put in the previous meeting were in vain. Attendees further discussed how to organise injects according to the 'main event list[8]'. In addition, the issue of 'emergency structure' was brought up again. In order to clarify each agency's responsibility, the consultant company produced a graph to define the relationship among all control posts and their roles (Figure 2). Similar issues were discussed in this meeting; however, most of them were unresolved still. Attendees decided to conduct an 'internal meeting' before the next planning meeting.

[8] 'The main event list' is a graph displayed in a time scale so that attendees could easily understand what happened at what time.

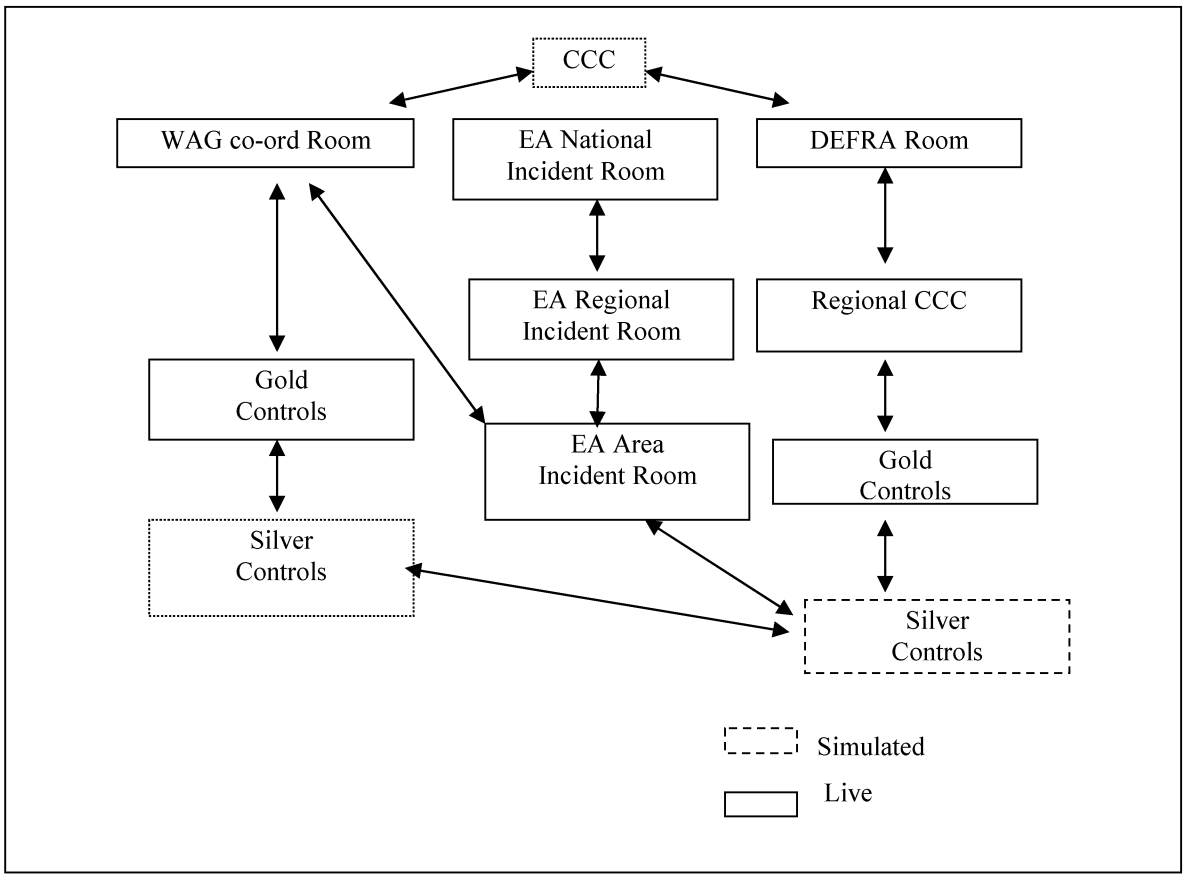

Figure 2. Proposed Control Posts Playing
Source: Exercise Communiqué 1, 2004.

Planners in the initial meeting collected and put together injects of each agency on the exercise Day-1. Planners used chronological order to examine the main event list. Attendees found that they needed more information to build a more realistic scenario. For example, they wanted to know how many people were influenced, the number of injured and dead, and damage to properties. This meeting summarised main injects that planners hoped participants would consider: (1) clear-up: pumping out water, (2) evacuation and rest centre: evacuating residences and homeless people in the flooded areas; (3) health issues: contaminated water, and drainage system, (4) the utilities problems, such as the power, gas and water, (5) traffic: motorways and railways, (6) the long term rehabilitation works, for example, houses, bridges, and re-establishment of businesses, and (7) public information dissemination.

There was a big change in the fourth meeting. Most control posts found that the impact of this flood hazard would be great; therefore, this exercise should include a longer recovery period in order to allow decision makers to establish holistic knowledge of responding time to flood hazards. As a result, the exercise Day-2 was changed to be a tabletop format which comprised two sessions: shorter-term recovery (one day to one week) and longer term recovery (one month to one year). Planners considered the following issues in order to establish the 'start state[9]' of the exercise day-2.

- How many people were drowned, how many dead?
- How many houses were affected?
- Basic information about local area.
- Utilities, such as water, sewage system and gas.
- Map

Planners also discussed how to deliver this information to their participants and how their players pass information to the regional office. There were still many uncertainties of the exercise Day-2.

Planners continued to discuss the format of the exercise Day-2 in the 5th planning meeting. The first topic for discussion was the set up of the exercise room. There would be a meeting room for the 'gold' players[10] to hold meetings, and a big room for other activities, for example, collecting and analysing information. Next, planners discussed the 'start state' for the exercise Day-2. The consultant company summarised the ideas suggested by planners in the previous meeting and produced a 'start state briefing matrix' (excerpt matrix appears in the table 4). Based on

[9] 'Start state' refers to the background of the exercise, and normally it is the initial situation of the exercise.
[10] It is according to the 'command and control structure' in the Home Office publication, *Dealing with Disaster*. The 'gold' are those officers at the strategic level.

the matrix, planners further examined the rationale of each inject. Issues that players should consider included staff availability, evacuation, closure of schools, day centres and leisure centres.

Table 4: Start State Briefing Matrix T + 2 Days (excerpt)

Serial	Factor	Control Post Area
3.1	Residential	• An estimated 1,200 properties have been flooded on Hayling Island. • A further 600 have been flooded in P city, and towns. • 100 other properties on the coast are still flooded and uninhabitable. • An estimated 10,000 people have had their homes flooded.
3.2	Power	• 15,000 properties are still without power.

The 6th planning meeting was to summarise and review the design of the exercise. Denver Porter, the representative of the consultant company, described how the exercise was planned:

> "It is a national exercise. The National Project Board is responsible for the overall planning of the exercise; it also coordinated local planning groups (they became lower control posts, LOCONs later in the exercise) to build up local scenarios. They included two areas in Wales, four counties in east coast, three in south coast, and the Thames. The central and regional government offices, the media, the military, and utilities also took part in this exercise."

Denver continued to say:

> "This exercise comprises two days. Exercise Day-1 was a control post exercise, played in a real-time base, which referred to the first day of the flood hazard. Exercise Day-2 was a tabletop exercise, which was divided into two sections: shorter-term recovery issues (covering the first month after the flooding), and longer-term recovery issues (including the first month to the first year)."

His presentation also summarised the roles and responsibilities of participants in the exercise. Lastly, he went through the procedure again in order to remind planners what to do in the exercise: each day would start with a 15-minute-briefing session, which was to inform players of the background of the hazard and what was going to be done. Next, the exercise started. The Day-1 was an 8-hour real time control post exercise[11]; the second day was a tabletop simulated time exercise. The morning session was the short-term recovery and the afternoon session was the long term recovery plan. After the eight-hour exercise, key players were required to take part in a structured debriefing session. It was planned to use this session to increase players' learning outcomes.

Due to the length of the paper, the observations and records of the exercise are not included in this paper. However, it is worth mentioning the structured debriefing in terms of learning outcomes. There was a facilitator appointed to lead the debriefing session. First of all, the facilitator highlighted that the objective of this debriefing was to:

- Reflect on your role in the running of this control post during the exercise.
- Identify personal experience
- Share views and discussion to establish: (1) personal learning, and its future positive use; and (2) ideas for the future to develop response to a similar flooding or other national emergency.

Then the facilitator requested players to write answers to the following questions on different coloured post-it notes:

- The great difficulties I experienced were:
- The most successful things I experienced were:
- The most significant things that I learned are:
- The three tips that I would now offer to someone taking over my role in the future are:

Gold players took turns to read their answers, and shared their ideas with other colleagues. In the meantime, the tutor posted the notes on a big poster hanging on the white board according to their categories. The categories to evaluate the exercise on the poster included: plans & procedures, liaison/coordination, resources/assets, information/data, communications, training, and public awareness/media. We could see clearly which category/categories was/were the weakness(es) and strength(s) of the exercise according to the colour notes.

Players found that the time limit was a major difficulty. They needed more time to complete most missions and tasks. The other difficulty was that the gold players could not make precise decisions because they did not have players on the ground. In addition, gold players suggested that all players should take part in the debriefing because they regarded this debriefing session as a useful method of enhancing learning outcomes.

However, generally the exercise was felt to have gone well. Players all agreed that they had experienced better teamwork on the Day-2. The layout of the exercise room on Day-2 was considered better than Day-1 because it was easier for players to communicate and interact with each other.

[11] A control post exercise was to train emergency response team leaders' ability of communication arrangement. Team leaders would be positioned in the control post (which will be functioned during actual event) to play the exercise.

In responding to the third question, most players learned to be flexible and adaptable in response to crisis situations. In addition, the relation between the regional office and local authorities were examined during the exercise. Moreover, players obtained a better understanding of responsibilities and compatibility towards their colleagues. Lastly, players also learned the importance of liaison support, for example, record keeping.

There were several constructive suggestions for future exercises. For example, a player from government regional office said, "we should be familiar with our roles and our responsibilities." (Issac Hacker). A local authority officer said, "We also need to know the requirements from our managers;" (Alice Quintin) she continued to say, "in addition to meet deadlines, we need to keep records properly." Alice Quintin commented, "in order to identify roles and tasks in every mission, it is important to hold a formal briefing and walk around to talk to people." This debriefing ended at four o'clock, and it was the end of the whole exercise.

FINDINGS

The main objective of the exercise was to test the ability of communication and coordination. The findings are summarised in the following section.

Talk Clearly, Listen Carefully?

The communication theory argued that communication is initially a linear process that a message is sent via a transmitter to a receiver. However, during this process, due to the way that the transmitter encodes message, and the way the receiver decodes the message, besides there are 'noises and barriers' during the delivery process, errors and misunderstanding could occur (Ellis & McClintock 1990).

Andrew Hart, an emergency planning manager at the city council, made an example during an interview, he said,

> "During an incident, people cannot give order clearly, and they do not listen carefully as well. He may only pick up the 'important' part. However, the 'important' may define differently from person to person."
>
> (Andrew Hart, Emergency Planning Manager, City Council).

Andrew further indicated that,

> "People in an incident do not stop to think. They attempted to respond at the shortest time. Misunderstanding would occur, once a misunderstanding occurred, it leads to more misunderstandings. However, during the debriefing session, people only remember they've made lots of wrong decisions – which are not correct because the problem is 'misunderstanding' rather than 'making wrong decision'."
>
> (Andrew Hart, Emergency Planning Manager, City Council).

This is a problem as there is a need to avoid decision makers making incorrect decisions. How to decrease the possible 'noises and barriers' in the communication process should be highlighted in the planning phase.

Talk to the right person?

Another approach to risk communication does not only stress the interaction between individuals, it also highlights the "interactive process of exchange of information and opinion among groups and institutions." (Pidgeon et al. 1984). Such definition points out a "fluid and dynamic interchange of information between the parties to a risk issue or conflict in the search for mutual understanding." (Pidgeon et al. 1984). Emergency management structure might influence the effectiveness of risk communication.

According to the Civil Contingencies Act, the DEFRA is the lead department to respond to floods, and has overall policy responsibility for flood defence and coast protection in England and Wales and administers grant-aid for capital defence schemes (DEFRA 2005). The EA has the operational responsibilities for flood defence, flood monitoring and warning on the coast and on designated "main rivers" in England and Wales. The main responsibilities of EA are to issue flood warning; maintenance and operation of vital flood defences, monitors water level and flows, and assessing risk and advising the emergency services and local authority. During a flood hazard, the Category 1 Group are the key actor to respond to a major incident. They include local authorities, emergency services, and health sectors.

The Home Office publication, *Dealing with Disasters*, designates the framework to deal with incidents, which is also called the 'command, control, and co-ordination' system. The management of the response is divided into three levels – operational, tactical, and strategic (which are also called the bronze, silver and gold). Each agency manages its own activities within this framework, while maintaining coordination with the other organizations. The flood management structure in the UK can be displayed as in Figure 3.

Although each agency set up their framework according to this command, control and co-ordination system, the hierarchical structures are slightly different from the Environment Agency and other agencies. In addition, each agency has its own jurisdiction. These factors delay decision makers making their decision because officers would spend more time communicating with people working in different jurisdictions. Perrow in his 'normal accident' theory indicates that once the system becomes tighter and more complex, it is subject to "overload, misperception, regression, and individualized response" (Perrow 1994), system failures would occur. It is suggested that to simplify the management structure could facilitate the effectiveness of the response activities.

Emergency service responders prefer centralizing the decision-making structure. However, this top-down structure is criticised because it is lack of flexibility and intensive response (Drabek 1986, t'Hart 1997; Boin & Otten 1996). Hence, creating an effective organizational response under a complex, uncertain circumstance becomes a challenge

for emergency service teams (Comfort 1993). Enhancing the interaction and communication between parallel levels and among different agencies facilitates the ability to obtain information, distribute resources, and promotes better coordination.

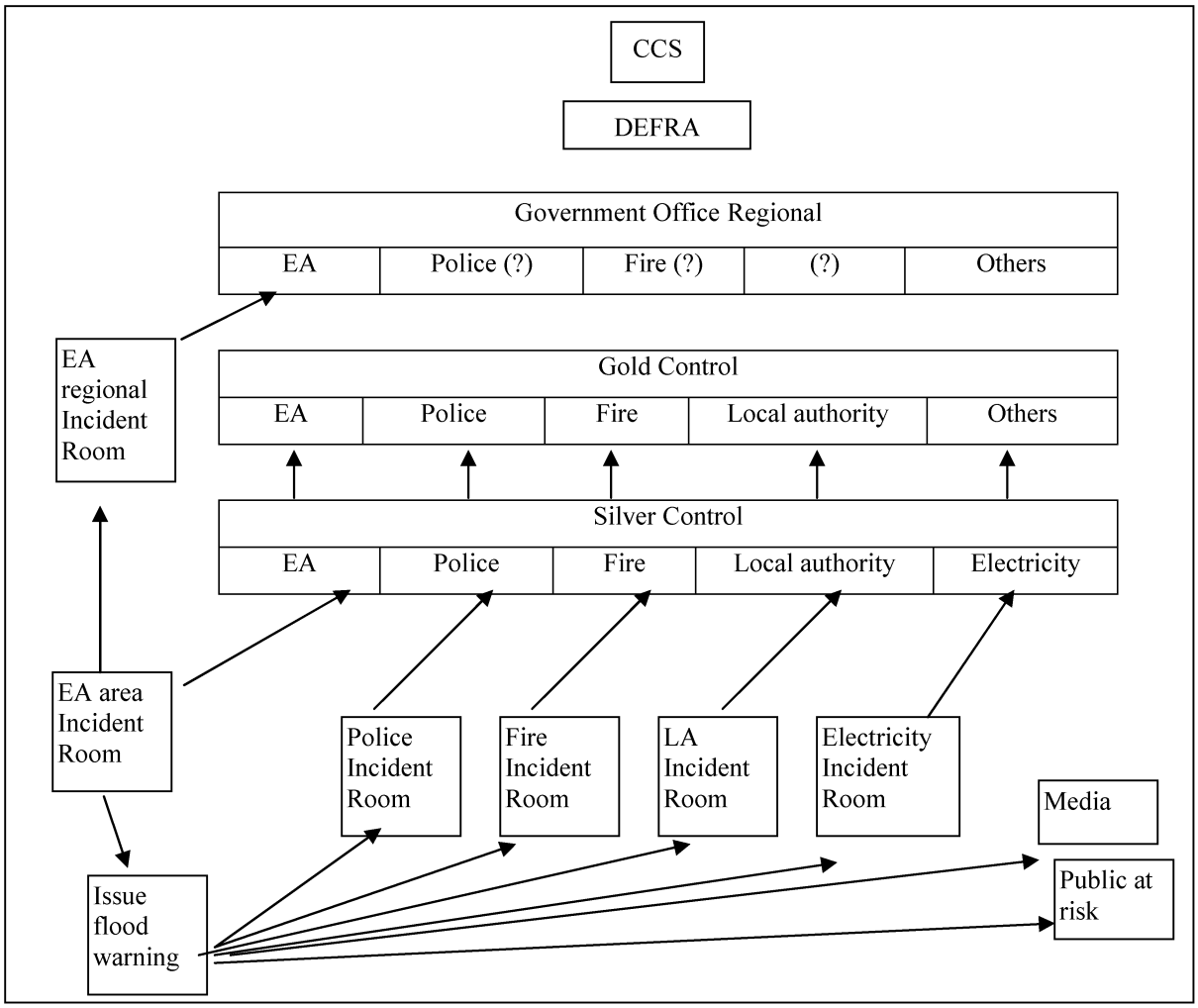

Figure 3. The emergency structure

Willing to talk?

Organisational boundaries and organisational culture could be other factors to prevent effective communication.

People tend to communicate with those they are familiar with which are normally in the same organisation. One of the interviewees said that:

> "You know, human nature, we tend to talk to those who we want to talk to, it is not always the right way to do it. It is very difficult to communicate because different ways of communications become disrupted or got bored or talk in different way."
>
> (Jack Donald, Emergency Planning Officer, Ambulance)

Either in the exercise planning meetings, or exercise days, emergency service personnel tended to form a sub-group; in contrast, officers from government bodies stayed in another sub-group. Participants prefer to stay in a group that they are familiar with because it provides a safe environment. Participants could avoid criticisms from other organisations. It is suggested that future research could focus on how to break the barriers either in the exercise or the reality.

CONCLUSIONS

The first section indicated strengths and weaknesses of different flood management paradigm. In order to overcome these problems, it is suggested to use simulations to train personnel involved in dealing with flood hazards. Next, the paper examined the definition and design of simulations. It used individual learning and organisational learning to answer why simulations facilitate learning outcomes. In addition, through analysing expertise, it provides a prospective for exercise planners to identify what an exercise should comprise. In order to obtain a better

understanding of what a flood exercise should comprise, the author used an ethnographic methodology to conduct a case study in southern England. The author then briefly described the case study and its findings. At the end of the paper, the author also suggested what could be taken into consideration in future flood simulations.

Acknowledgements: Add your acknowledgements here using the *Text* style in this document's style sheet.

Corresponding author: Miss Yung-Fang Chen, University of Portsmouth, 4.20 Park Building, King Henry 1 Street, Portsmouth, Hampshire, PO4 0AS, United Kingdom. Tel: +44 2392 846 157. Email: nicole.chen@port.ac.uk.

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